

**WHAT IS CLAIMED IS:**

- 1                    1.        A method for measuring a physiological parameter, comprising:  
2                    measuring a plurality of signals, wherein each of said signals comprises a  
3 source component corresponding to said physiological parameter and an interference  
4 component;  
5                    processing said plurality of signals to obtain a plurality of principal  
6 components;  
7                    processing said plurality of principal components to obtain a plurality of  
8 independent components, wherein a matrix of said plurality of signals corresponds to a matrix  
9 product of a matrix of said plurality of independent components and a matrix of mixing  
10 coefficients; and  
11                    extracting a first measure of said physiological parameter corresponding to  
12 said source component from one of said plurality of independent components.
- 1                    2.        The method of claim 1 wherein said physiological parameter is a  
2 function of an oxygen saturation.
- 1                    3.        The method of claim 1 wherein said physiological parameter is a  
2 function of a pulse rate.
- 1                    4.        The method of claim 1 wherein said plurality of signals corresponds to  
2 sensed optical energies from a plurality of wavelengths.
- 1                    5.        The method of claim 1 wherein said plurality of signals corresponds to  
2 sensed optical energies from a plurality of wavelengths from different times.
- 1                    6.        The method of claim 1 wherein said processing said plurality of signals  
2 further comprises  
3                    obtaining a time derivative of the sensed optical energies from a plurality of  
4 wavelengths.
- 1                    7.        The method of claim 1 wherein said interference component comprises  
2 signal components caused by motion, respiratory artifact, ambient light, optical scattering and  
3 other interference between a tissue location being sensed and a sensor.

1                   8.     The method of claim 1 wherein said processing said plurality of signals  
2 further comprises decorrelating said plurality of signals by minimizing a cross-correlation of  
3 said plurality of signals, to obtain a plurality of decorrelated signals; and  
4                   normalizing said plurality of decorrelated signals to obtain a plurality of  
5 principal components.

1                   9.     The method of claim 1 wherein said processing said plurality of signals  
2 comprises decorrelating said plurality of signals by singular-value decomposition of said  
3 plurality of signals, to obtain a plurality of principal components.

1                   10.    The method of claim 1 wherein said processing said plurality of signals  
2 comprises decorrelating said plurality of signals by multiplying said plurality of signals by  
3 the inverse square root of the covariance matrix of said plurality of signals to obtain a  
4 plurality of principal components.

1                   11.    The method of claim 1 wherein said processing of said plurality of  
2 principal components comprises higher-order decorrelation of said plurality of principal  
3 components.

1                   12.    The method of claim 1 wherein said processing said plurality of  
2 principal components comprises maximizing a function of the higher-order cumulants of a  
3 mixture of said plurality of signals, thus separating said source component from said  
4 interference component.

1                   13.    The method of claim 12 wherein said higher-order cumulant is  
2 cumulant having order greater than two.

1                   14.    The method of claim 12 wherein said higher-order cumulant is a third-  
2 order cumulant of said plurality of signals.

1                   15.    The method of claim 12 wherein said higher-order cumulant is a  
2 fourth-order cumulant of said plurality of signals.

1                   16.    The method of claim 1 further comprising obtaining a ratio of mixing  
2 coefficients from said matrix of mixing coefficients, wherein said ratio corresponds to a ratio  
3 of modulation ratios of red to infrared signals, wherein said plurality of signals comprise  
4 modulated optical signal in the red and infrared ranges.

1                   17.     The method of claim 1 further comprising extracting a second measure  
2 of said physiological parameter from said ratio, wherein said second measure of said  
3 physiological parameter corresponds to an oxygen saturation.

1                   18.     The method of claim 1 wherein said first measure of a physiological  
2 parameter corresponds to a pulse rate.

1                   19.     The method of claim 1 further comprising extracting said interference  
2 component from another one of said plurality of independent components.

1                   20.     A pulse oximeter, comprising:  
2                   a sensor configured for measuring a plurality of signals, wherein each of said  
3 signals comprises a source component corresponding to said physiological parameter and an  
4 interference component;  
5                   a computer useable medium having computer readable code embodied therein  
6 for measuring a physiological parameter, said computer readable code configured to execute  
7 functions comprising:  
8                                 processing said plurality of signals to obtain a plurality of  
9                   principal components;  
10                                processing said plurality of principle components to obtain a  
11                   plurality of independent components, wherein a matrix of said plurality of signals  
12                   corresponds to a matrix product of a matrix of said plurality of independent  
13                   components and a matrix of mixing coefficients; and  
14                                extracting a first measure of said physiological parameter  
15                   corresponding to said source component from one of said plurality of  
16                   independent components.

1                   21.     The pulse oximeter of claim 20 wherein said physiological parameter  
2 is an oxygen saturation.

1                   22.     The pulse oximeter of claim 20 wherein said physiological parameter  
2 is a pulse rate.

1                   23.     The pulse oximeter of claim 20 wherein said plurality of signals  
2 corresponds to sensed optical energies from a plurality of wavelengths.

1                   24.    The pulse oximeter of claim 20 wherein said plurality of signals  
2 corresponds to sensed optical energies from a plurality of wavelengths from different times.

1                   25.    The pulse oximeter of claim 20 wherein said plurality of signals  
2 corresponds to the time derivative of the sensed optical energies from a plurality of  
3 wavelengths.

1                   26.    The pulse oximeter of claim 20 wherein said interference component  
2 comprises signal components caused by motion, respiratory artifact, ambient light, optical  
3 scattering and other interference between a tissue location being sensed and a sensor.

1                   27.    The pulse oximeter of claim 20 wherein said processing said plurality  
2 of signals comprises decorrelating said plurality of signals by minimizing a cross-correlation  
3 of said plurality of signals, to obtain a plurality of decorrelated signals; and  
4                   normalizing said plurality of decorrelated signals to obtain a plurality of  
5 principal components.

1                   28.    The pulse oximeter of claim 20 wherein said processing said plurality  
2 of signals comprises decorrelating said plurality of signals by singular-value decomposition  
3 of said plurality of signals, to obtain a plurality of principal components.

1                   29.    The pulse oximeter of claim 20 wherein said processing said plurality  
2 of signals comprises decorrelating said plurality of signals by multiplying said plurality of  
3 signals by the inverse square root of the covariance matrix of said plurality of signals to  
4 obtain a plurality of principal components.

1                   30.    The pulse oximeter of claim 20 wherein said processing of said  
2 plurality of principal components comprises higher-order decorrelation of said plurality of  
3 principal components.

1                   31.    The pulse oximeter of claim 20 wherein said processing said plurality  
2 of principal components comprises maximizing a function of the higher-order cumulants of a  
3 mixture of said plurality of signals, thus separating said source component from said  
4 interference component.

1                   32.    The pulse oximeter of claim 31 wherein said higher-order cumulant is  
2 cumulant having order greater than two.

1                    33.    The pulse oximeter of claim 31 wherein said higher-order cumulant is  
2 a third-order cumulant of said plurality of signals.

1                    34.    The pulse oximeter of claim 31 wherein said higher-order cumulant is  
2 a fourth-order cumulant of said plurality of signals.

1                    35.    The pulse oximeter of claim 20 wherein said processing said plurality  
2 of principal components comprises successive transformations to simultaneously minimize  
3 second- and higher-order correlations among the outputs.

1                    36.    The pulse oximeter of claim 20 wherein said processing said plurality  
2 of principal components comprises successive rotations to minimize estimated mutual  
3 information among the outputs.

1                    37.    The pulse oximeter of claim 20 further comprising obtaining a ratio of  
2 mixing coefficients from said matrix of mixing coefficients, wherein said ratio corresponds to  
3 a ratio of modulation ratios of red to infrared signals.

1                    38.    The pulse oximeter of claim 20 further comprising extracting a second  
2 measure of said physiological parameter from said ratio, wherein said second measure of said  
3 physiological parameter corresponds to an oxygen saturation.

1                    39.    The pulse oximeter of claim 20 wherein said first measure of a  
2 physiological parameter corresponds a pulse rate.

1                    40.    The pulse oximeter of claim 20 further comprising extracting said  
2 interference component from another one of said plurality of independent components.